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MENDELÉEFF'S PRINCIPLES OF CHEMISTRY.

The Principles of Chemistry. By D. Mendeléeff. Translated from the Russian (sixth edition) by George Kamensky, A.R.S.M. Edited by T. A. Lawson, B.Sc., Ph.D. Two vols. Pp. xviii + 621 and 518. (London: Longmans, Green, and Co., 1897.)

AN English translation of the earlier (fifth) edition of this remarkable book was prepared by Mr. Kamensky, and edited by Mr. A. J. Greenaway, in 1891. It is therefore familiar to the English chemical world; and that a second edition of the English version should be called for in a comparatively short time, is a proof that the views of the author have a fascination which secures for the book a wide circle of readers. The author speaks of it modestly "as an elementary textbook of chemistry"; but it is probable that the previous edition has been exhausted less by a demand on the part of beginners in the subject, for whom, to say truly it is little adapted, than as a consequence of the interest which has been excited among advanced students and professed chemists by the exposition of the doctrine embodied in the so-called "Periodic Law," which is the principal feature of the work. Enough has already been said in the pages of NATURE (see vol. xlv. p. 529) concerning the characteristics of the book itself—the extraordinary development of the foot-notes, which often expand to such dimensions as almost to drive the text out of the page, and which in many cases contain far more interesting matter; the strange inequality in the materials collected, many processes, especially those connected with manufactures, being quite antiquated; and others which need not be recalled. The confusion of proper names, owing to errors of spelling, is not so conspicuous as in the former editions, though one ludicrous substitution occurs in the chapter on spectrum analysis, where Huggins is three times over transformed into Huyghens! Such defects, however, do very little to impair the real value of the book, or obscure the genius of the author. Turning from the attitude of the literary critic to that of the scientific inquirer, it is much more profitable to see what such a chemist as Mendeléeff has to say about special questions of fundamental or primary importance.

In chemistry the word element is in constant use in the sense originally taught by Boyle, that is, signifying something which has up to the present remained undecompounded. At the present day the majority of chemists have probably settled down to the belief that our seventy or eighty "elements" represent limiting material, and that, so far as terrestrial affairs are concerned, so they will always remain. Others—probably however, a minority—conceive that relations among their atomic weights hint that they may be compounded of finer matter united in various ways, and though they may not expect to rupture the bond which unites the subatomic constituents together by any laboratory process, yet they see in the spectral phenomena of the stars evidence that under other conditions this rupture may actually be accomplished. Mendeléeff seems to believe in the permanence of the terrestrial elements, for not only in the two foot-notes on p. 20, vol. i., but in a long digression upon the subject of Prout's hypothesis (p. 439-441, vol. ii.), he emphatically rejects the idea that the atomic weights of other elements have any definite numerical relation to that of hydrogen, and he points out that attempts at transmutation of one element into another have been hitherto fruitless. "All such ideas and hopes," he says, "must now, thanks more especially to Stas, be placed in a region void of any experimental support whatever, and therefore not subject to the discipline of the positive data of science." Now and again, even at the present day, there is a recrudescence of alchemistic pretensions, but it may be noticed that the discovery for which a claim is put forward always relates to the transmutation of a base metal into silver or silver into gold. If any one suggested that he had succeeded, for example, in extracting lead from thallium, he would be laughed at for his pains, but if he boldly asserts that by a long and secret process he has succeeded in making gold out of silver, he generally finds a few people at least ready to take him seriously.

Chemical affinity is another expression still freely used, though with widely different meanings by different chemists; and here again a definite expression of the author's views is fortunately to be found in the pages of his book. He says (p. 27):

> "For a long time, and especially during the first half of this century, chemical attraction and chemical forces were identified with electrical forces. There is certainly an intimate relation between them, for electricity is evolved in chemical reactions, and has also a powerful influence on chemical processes—for instance, compounds are decomposed by the action of an electric current. And the exactly similar relation which exists between chemical phenomena and the phenomena of heat (heat being developed by chemical phenomena, and heat being able to decompose compounds) only proves the unity of the forces of nature, the capability of one force to produce and to be transformed into others. For this reason the identification of chemical force with electricity will not bear experimental proof."

He then goes on in a characteristic foot-note to refer to the facts of substitution or "metalepsy," in which hydrogen, a "positive" element, may be exchanged for chlorine, a "negative" element, without altering the chief chemical characters of the compounds in which the exchange occurs. On a later page, also in a foot-note the author gives an account of the electro-chemical theories of Davy and Berzelius, and their relation to successive hypotheses of the constitution of salts; and here again he seems to reject all modifications of Berzelius' polar doctrine. It must be admitted, however, that the book is not strong in this direction. After much research we have not succeeded in finding a definite statement of such important facts as are embodied in Faraday's laws of electrolysis, the nearest approach to it being found on p. 581, but followed by an apologetic foot-note in which it is stated that the plan and dimensions of the book prevent the author from "entering upon this province of knowledge." This is to be regretted, considering the importance to the chemical student of a good acquaintance with the facts, methods

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and hypotheses of the now largely-developed province of electro-chemistry.

The preface of the new edition contains a special reference to the author's views concerning solutions—a subject for which he expresses great personal predilection, and to the experimental investigation of which he has devoted some time and labour. A paper by Mendeléeff relating to solutions of alcohol in water was communicated to the Chemical Society of London in 1887. He now states that we have not yet "the right to consider even the most elementary questions respecting solutions as solved." "My own view is that a solution is a homogeneous liquid system of unstable dissociating compounds of the solvent with the substance dissolved." In a foot-note, beginning p. 64, he explains the gas theory as applied to dilute solutions, and expresses the view that the physical and chemical aspects of the question, referring respectively to dilute and strong solutions, must be reconciled. The passage is too long for quotation; but supporters of the so-called hydrate theory may still count the great Russian chemist as on their side, at any rate so far as strong solutions are concerned.

There are, of course, many other subjects which the reader of the book will pursue with much interest, in view of the eminence of the author and the originality with which they are treated; but none of these will equal in attractiveness the subject of the grouping of the elements and the development of the periodic law. It is interesting to remember that, as the author tells us in the preface (p. xii), it was while engaged in writing the first edition of the book in 1869 that he first perceived the scheme and the application of the periodic law in its entirety. But it is only at the opening of the second volume that we come to the exposition of the principles which guided him in the grouping of the elements. This is accompanied by a foot-note which contains a historical *résumé* of the course of events which led ultimately to the recognition of these important principles by all chemists. And here we find a passage (*note* 13, p. 26) which sets forth clearly the depth and solidity of Mendeléeff's conception of the periodic "law," and the superiority of his claim to be regarded as the discoverer of the relation of properties to atomic weight among the elements. Having become convinced that the atomic weights and properties of the elements were mutually related in a certain manner, the Russian chemist did not hesitate to alter accepted atomic weights when required to fall in with the scheme, and to predict the properties of then undiscovered elements; while "neither De Chancourtois, to whom the French ascribe the discovery of the periodic law, nor Newlands, who is put forward by the English, nor L. Meyer, who is now cited by many as its founder, ventured to" do anything of the sort.

As such fortunate and valuable consequences have happily followed the study of the atomic weights by Mendeléeff, it is perhaps hypercritical to complain of his use of the term "law" in the vulgar ambiguous sense.

What after all is a "law of nature"? Is it not a compendium or summary of a series of observed agreements? and the statement so often used by Mendeléeff, that "the laws of nature admit of no exception," by no means proves that exceptions to any and every recognised law of nature may not hereafter be discovered. As such a statement now stands, it merely implies that in most cases the induction is at present incomplete. The question now comes, whether the periodic law itself is a "law of nature"? This is a question which must be troubling very much the discoverer of the law at the present time, now that the individuality of argon and, though less certainly, that of helium have been established. The subject is dealt with in Appendix iii. at the end of the second volume, written by Prof. Mendeléeff in February 1895, and here he clings to the idea that argon is a polymeride of nitrogen, or N_3.

This hypothesis, however, cannot be maintained. All that is known of argon shows that it is a gas having a density lower than 20 (H = 1), and hence that its molecular weight is less than 40, while that of N_3 would be 42. Argon and helium can at present be regarded only as a kind of chemical monsters brought unexpected and unwelcome, like the cuckoo, into the previously happy family of the elements where no place is provided for them. What, then, becomes of the "law of nature" if these two substances are admitted to be exceptions to the law as it now stands? and yet that they are exceptions is the conclusion which seems inevitable. W. A. T.

THE NATURAL HISTORY OF THE ANCIENT WORLD.

Les Choses Naturelles dans Homère. Par le Dr. A. Kums. Pp. 194. (Antwerp: Buschmann. Paris: Alcan, 1897.)

Gleanings from the Natural History of the Ancients. By the Rev. M. G. Watkins, M.A. Pp. xiii + 258. (London: Elliot Stock, 1896.).

The Works of Xenophon. Translated by H. G. Dakyns, M.A. Vol. iii. part ii. Pp. lxx + 130. (London: Macmillan and Co., Ltd., 1897.)

Aristotle on Youth and Old Age, Life and Death and Respiration. Translated, with Introduction and Notes, by W. Ogle, M.A., M.D. Pp. 135. (London: Longmans and Co., 1897.)

THE consideration of the animal world is usually approached from one or other of three points of view. We may be interested in the structure—the morphology and physiology—of animals, and in their place in nature: this is the biological interest. Or we may be especially interested in their habits and doings, and every one has at least observed something of the characters and ways of more than one species of animal. Or we may regard animals as objects of the chase or material for human food. The first of these interests is purely scientific; it must exclude hearsay and fancy; it must be based on the most careful observation and examination with the aid of all the appliances that contemporary art and manufacture can furnish; and it must admit nothing that is unverifiable or supported by doubtful authority. On the other hand, the study of the habits and characters of animals can seldom confine itself to lines so rigidly laid down as these; not only is it extremely difficult for the most scientific investigators to interpre or even to record the actions of the lower creatures without a certain, often unconscious, anthropomorphism or reading-in of motives into them; but we are also confronted by a mass of current beliefs and superstitions, and imperfectly authenticated tales which, in view of their frequent repetition and the widespread evidence accorded

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